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VI. When $x = 143.27$ then $y < 0$ and $A = 0$. Since $x < 192.5$, $(2x + y)2x > 0$ by (5). And since $A = 0$, $(2x + y)2x = |70y|$. Fig. 12 is again representative and the positive and negative areas just balance.

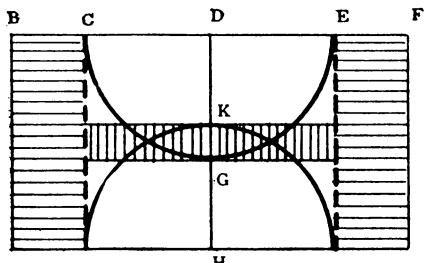


FIG. 12.

$$102.67 < x < 192.5, y < -x.$$

and Fig. 14 is representative.

In V, VI, VII, the race-track is partly positive and partly negative. In equation (2) the $2\pi x$ is positive and the $2y$ is negative as is indicated in the figures by the solid and dotted parts of the track.

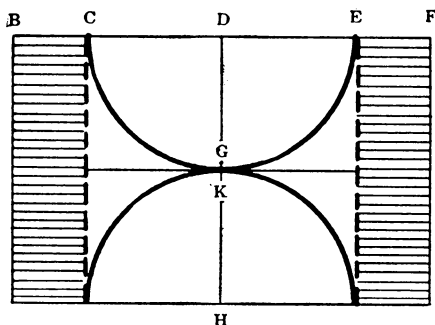


FIG. 13.

$$x = 192.5, y = -2x.$$

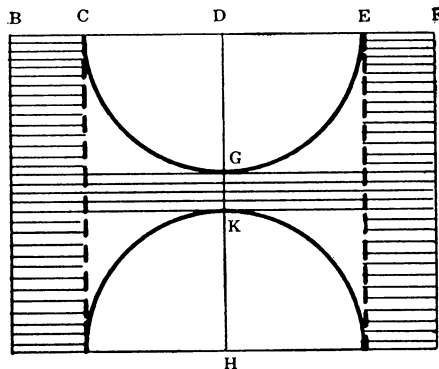


FIG. 14.

$$192.5 < x + \infty, y < -2x.$$

Also solved by HORACE OLSON, S. E. URNER, PAUL CAPRON, and J. W. BALDWIN.

MECHANICS.

336. Proposed by C. N. SCHMALL, New York City.

An inclined plane, length l , makes an angle $\phi < (\frac{1}{2}\pi)$ with the horizontal plane through its foot. From its foot, a body is projected upward along the plane, with a velocity equal to that of a falling body at the height h , so as to pass over the top and strike the horizontal plane at the maximum distance, x , from the foot of the inclined plane. Show by methods of the calculus that $x = h/(\sin \phi \cos \phi)$, and that the corresponding value of l is $(2h \cot 2\phi)/\cos \phi$.

SOLUTION BY THE PROPOSER.

Let v_1 = velocity at time of projection; v = velocity on reaching top of plane; a = height of inclined plane; x_1 = horizontal distance traversed by body after leaving plane.

Then, by the given conditions, we have

$$v_1^2 = 2gh, \quad (1)$$

$$a = l \sin \phi, \quad (2)$$

$$v^2 = 2g(h - a), \quad (3)$$

$$x = x_1 + a \cot \phi, \quad (4)$$

or,

$$x_1 = x - a \cot \phi. \quad (5)$$

Now taking the top of the inclined plane as the origin, the equation of the path of the body is

$$\begin{aligned} -a &= x_1 \tan \phi - \frac{g}{2} \frac{x_1^2}{v^2 \cos^2 \phi} \\ &= x_1 \tan \phi - \frac{g}{2} \frac{x_1^2}{2g(h - a) \cos^2 \phi} \end{aligned} \quad (6)$$

by equation (3). Whence,

$$(h - a)(a + x_1 \tan \phi) = \frac{x_1^2}{4 \cos^2 \phi}$$

which, putting $x - a \cot \phi$ for x_1 from (5), becomes

$$(h - a)x \tan \phi = \frac{(x - a \cot \phi)^2}{4 \cos^2 \phi}.$$

Hence,

$$x^2 - 2x(a \cot \phi \cos 2\phi + h \sin 2\phi) + a^2 \cot^2 \phi = 0, \quad (7)$$

where x is to be made a maximum.

Differentiating with respect to a , we get

$$\{x - (a \cot \phi \cos 2\phi + h \sin 2\phi)\} \frac{dx}{da} - x \cot \phi \cos 2\phi + a \cot^2 \phi = 0. \quad (8)$$

Hence,

$$\frac{dx}{da} = 0, \quad \text{if} \quad x = a \frac{\cot \phi}{\cos 2\phi}.$$

Putting this value of x in (7) and reducing, we get

$$a = h \frac{\cos 2\phi}{\cos^2 \phi}. \quad (9)$$

Again, substituting this value of x in the coefficient of dx/da in (8), we get

$$a \frac{\cot \phi}{\cos 2\phi} - a \cot \phi \cos 2\phi - h \sin 2\phi,$$

which is nearly equal to $h \sin 2\phi$.

It is evident, therefore, that as a increases through the value $h(\cos 2\phi)/(\cos^2 \phi)$, the coefficient of dx/da remains about equal to $h \sin 2\phi$, a positive quantity, while the remainder of equation (8), namely, $-x \cot \phi \cos 2\phi + a \cot^2 \phi$, changes from $-$ to $+$, for x is constant and a is increasing. Hence, dx/da changes from $+$ to $-$. Hence x is a maximum when

$$x = a \frac{\cot \phi}{\cos 2\phi} = \frac{h}{\sin \phi \cos \phi}. \quad \text{by (9)}$$

Also, from (2), we get

$$l = \frac{a}{\sin \phi} = 2h \frac{\cot 2\phi}{\cos \phi}. \quad \text{by (9)}$$

Also solved by O. S. ADAMS and HORACE OLSON.

NUMBER THEORY.

255. Proposed by FRANK IRWIN, University of California.

Given any arithmetical progression whose first term a and common difference d are relatively prime integers, and any finite set of positive integers m_1, m_2, \dots also relatively prime to d , it is required to determine an integer n such that the multiples of m_1, m_2, \dots may occupy the same